Performance Results of CERES Instrument Sensors aboard EOS Terra and Aqua Spacecraft using Tropical Ocean Measurements

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OUTLINE

- BRIEF DESCRIPTION ON CERES
- VALIDATION STUDIES CONDUCTED ON THE CERES SENSORS
- TROPICAL MEAN (TM) STUDY AND IT'S APPLICATIONS
- TM RESULTS FOR CERES INSTRUMENTS
- CONCLUSION

CERES EXPERIMENT

- **MEASURE TOP OF THE ATMOSPHERE (TOA) AND SURFACE RADIATIVE FLUXES AS CONTINUATION OF THE EARTH RADIATION BUDGET (ERB) MEASUREMENTS**
- **PROVIDE CLOUD PROPERTY ESTIMATES CONSISTENT WITH RADIATIVE FLUXES FROM SURFACE TO TOA**
- **4 OPERATIONAL CERES INSTRUMENTS ON-ORBIT**
  - **FLIGHT MODELS 1&2(FM1 & FM2) - TERRA**
  - **FLIGHT MODELS 3&4(FM3 & FM4) - AQUA**

CERES SENSOR CHARACTERISTICS

- **DETECTOR: BLACKENED THERMISTOR BOLOMETER**
- **SAMPLE TIME: 10 MILLISECONDS**
- **SCAN PERIOD: 6.6 SECONDS**
- **FOV@NADIR: (20) KM**

CHANNELS	**TOTAL**	**SHORTWAVE**	**WINDOW**
SPECTRAL RANGE	**0.3 - >100μm**	**0.3 - 5.0 μm**	**8.0 -12.0μm**

CALIBRATION & VALIDATION STUDIES

- **ON-BOARD CALIBRATION UNITS**
  - **INTERNAL CALIBRATION MODULE (ICM)**
  - **MIRROR ATTENUATOR MOSAIC (MAM)**

- **VALIDATION STUDIES**
  - **TROPICAL MEAN ANALYSIS**
  - **THREE CHANNEL INTERCOMPARISON**
  - **DIRECT COMPARISON OF SENSORS**

TROPICAL MEAN (TM) STUDY

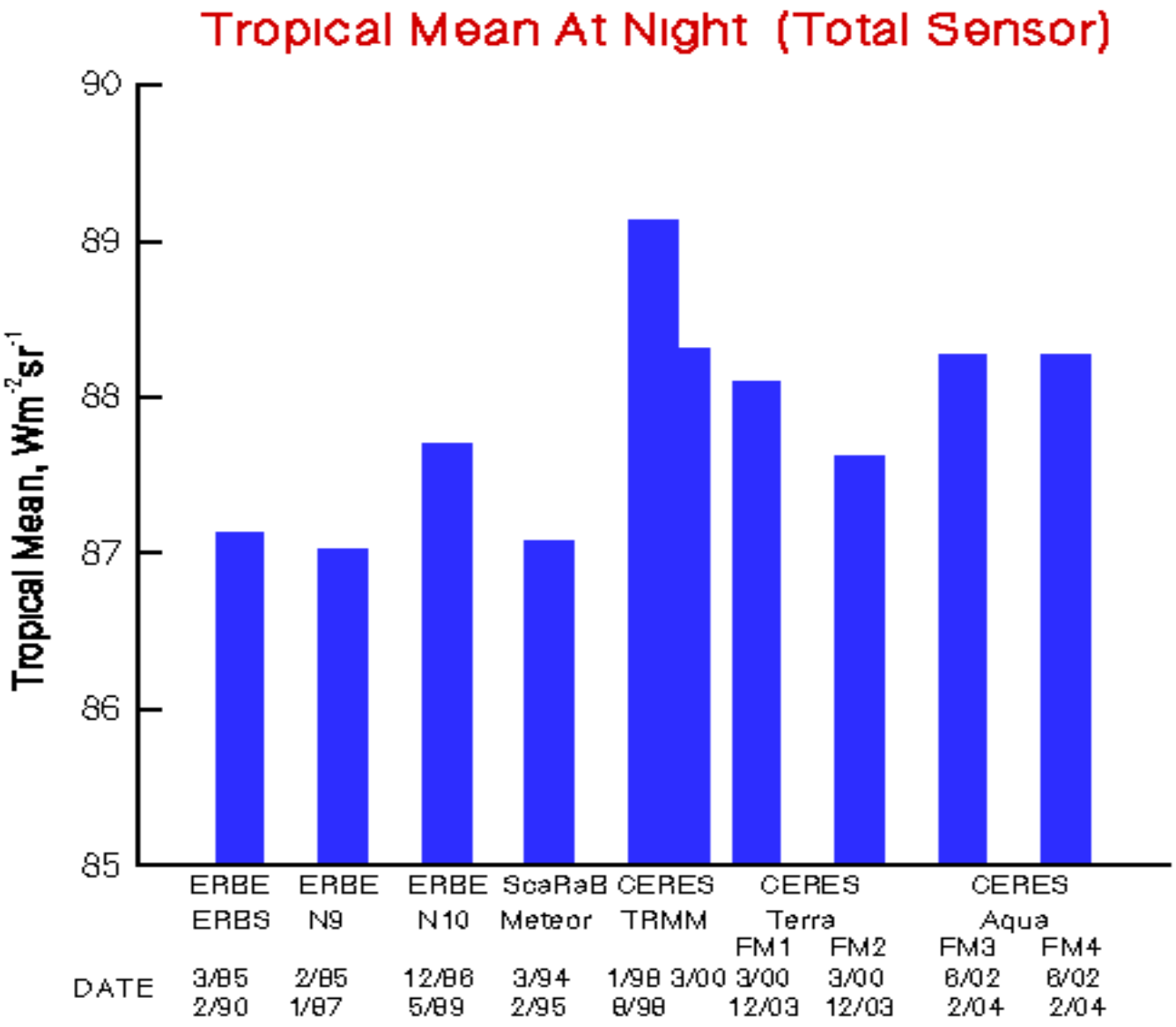
- **TM IS THE AVERAGE OF NADIR RADIANCES OVER TROPICAL OCEAN UNDER ALL SKY CONDITIONS.**
- **INDIVIDUAL SAMPLES ARE IN LATITUDE REGION OF +/-20^0 FROM EQUATOR.**
- **THE AVERAGE DAILY TM RADIANCE SHOULD BE IN THE MEAN LATITUDE OF 0.1 +/-2^0 AND LONGITUDE OF 185 +/-20^0**

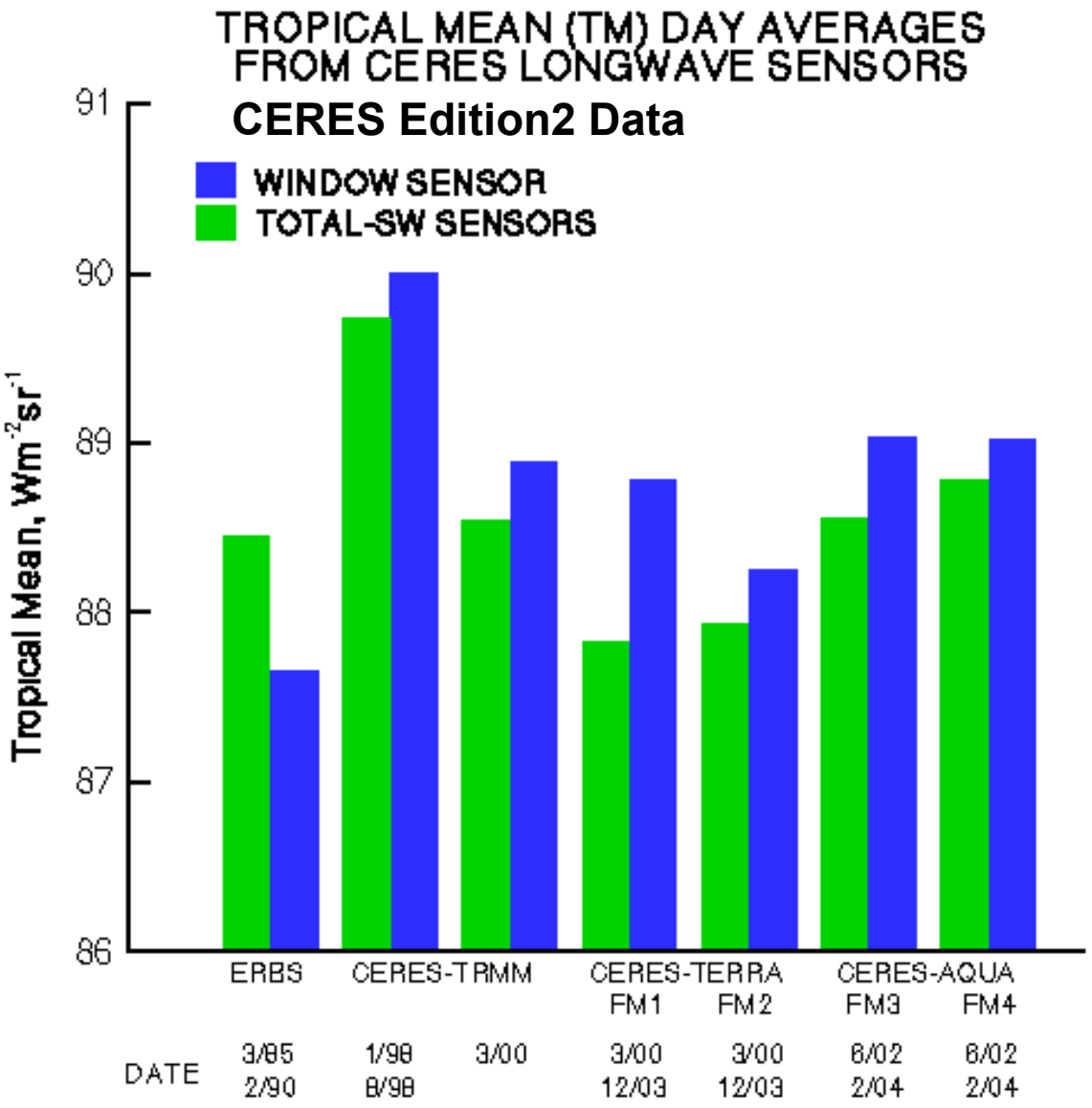
TROPICAL MEAN (TM) STUDY

- **CHOICE OF TROPICAL OCEAN MINIMIZES THE DUIRNAL EFFECT IN THE DATA.**
- **THE DUIRNAL EFFECT IN TM VALUE IS MODELLED AND CORRECTION IS APPLIED FOR ADJUSTING TM VALUE TO A COMMON TIME.**
- **NOON ORBIT IS TAKEN AS THE COMMON TIME FOR TM STUDY.**

LONGWAVE (LW) TM VALUE

- LONGWAVE NIGHT-TIME TM IS VERY STABLE OVER TIME.
- 5-YEAR TM DATA FROM ERBS INSTRUMENT IS USED TO VALIDATE THE TM STATISTIC.
- DAYTIME LW TM VALUE WAS DERIVED BY TWO METHODS
  - TOTAL AND SHORTWAVE SENSORS
  - LONGWAVE (WINDOW) SENSOR


Tropical Mean At Night (Total Sensor)
Tropical Mean, Wm-2sr-1
90
89
88
87
86
85
ERBE ERBS
ERBE N9
ERBE N10
ScaRaB Meteor
CERES TRMM
CERES Terra
CERES Aqua
FM1
FM2
FM3
FM4
DATE
3/85 2/90
2/85 1/87
12/86 5/89
3/94 2/95
1/98 3/00 8/98
3/00 12/03
3/00 12/03
6/02 2/04
6/02 2/04


TROPICAL MEAN (TM) DAY AVERAGES
FROM CERES LONGWAVE SENSORS
CERES Edition2 Data
WINDOW SENSOR
TOTAL-SW SENSORS
Tropical Mean, Wm-2sr-1
91
90
89
88
87
86
ERBS
CERES-TRMM
CERES-TERRA
FM1
FM2
CERES-AQUA
FM3
FM4
DATE
3/85
2/90
1/98
8/98
3/00
3/00
12/03
3/00
12/03
6/02
2/04
6/02
2/04

TM DAY-NIGHT DIFFERENCE (DN)

- **DAY-NIGHT DIFFERENCE (DN) IS CALCULATED FROM BOTH LONGWAVE SENSORS.**

  1. TOTAL AND SHORTWAVE SENSOR

  $DN_{TOT,SW}$ = TM(day,TOT-SW) -TM(night,TOT)

  2. LONGWAVE/WINDOW SENSOR

  DN_{LW} = TM(day, LW) - TM(night, LW)

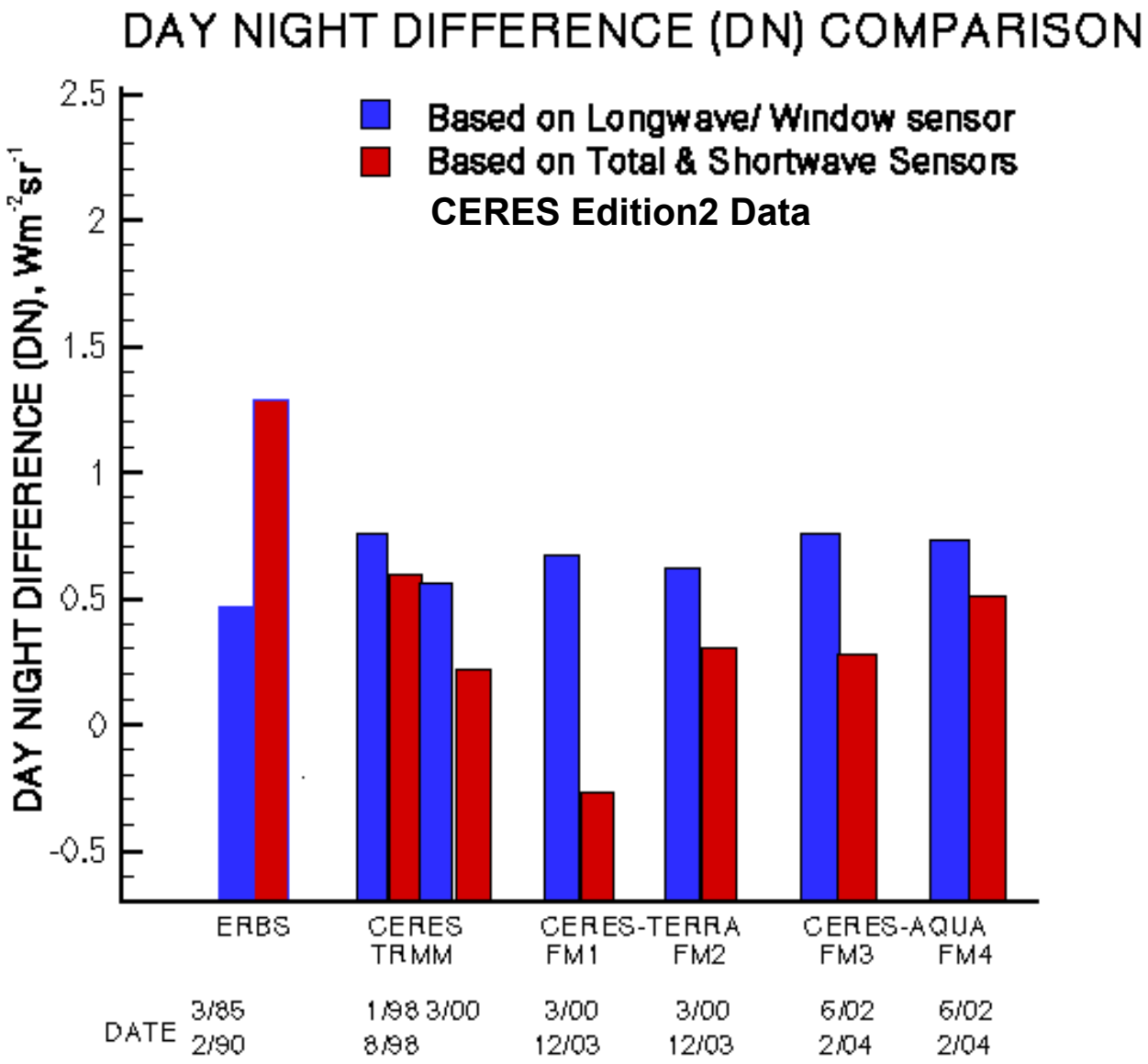
TM DAY-NIGHT DIFFERENCE (DN)

- **DN FROM WINDOW SENSOR IS MORE RELIABLE SINCE IT IS INSENSITIVE TO CALIBRATION ERROR.**

- **AVERAGE DN VALUE FROM WINDOW SENSOR FOR ALL CERES INSRUMENTS IS 0.68 +/-0.08 $Wm^{-2}sr^{-1}$.**

TM DAY-NIGHT DIFFERENCE (DN)

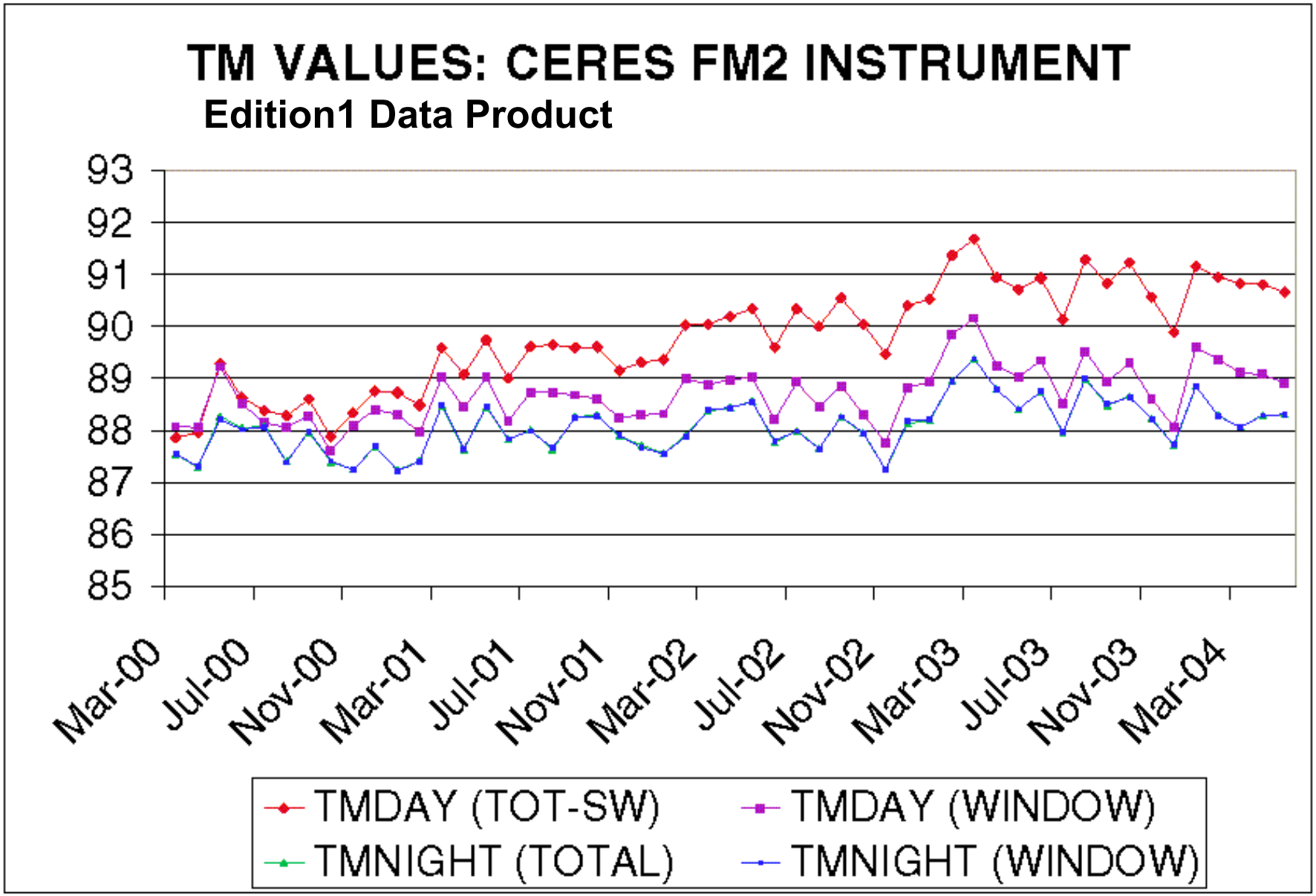
- **DN FROM TOTAL-SHORTWAVE SENSORS IS SENSITIVE TO CALIBRATION DRIFTS IN EITHER OF THE SENSORS.**
- **DN FROM TOTAL-SHORTWAVE SENSORS IS MORE VARIABLE BETWEEN CERES INSTRUMENTS.**
- **AVEREAGE VALUE FOR ALL CERES INSRUMENTS IS 0.27 +/-0.3 $Wm^{-2}sr^{-1}$.**

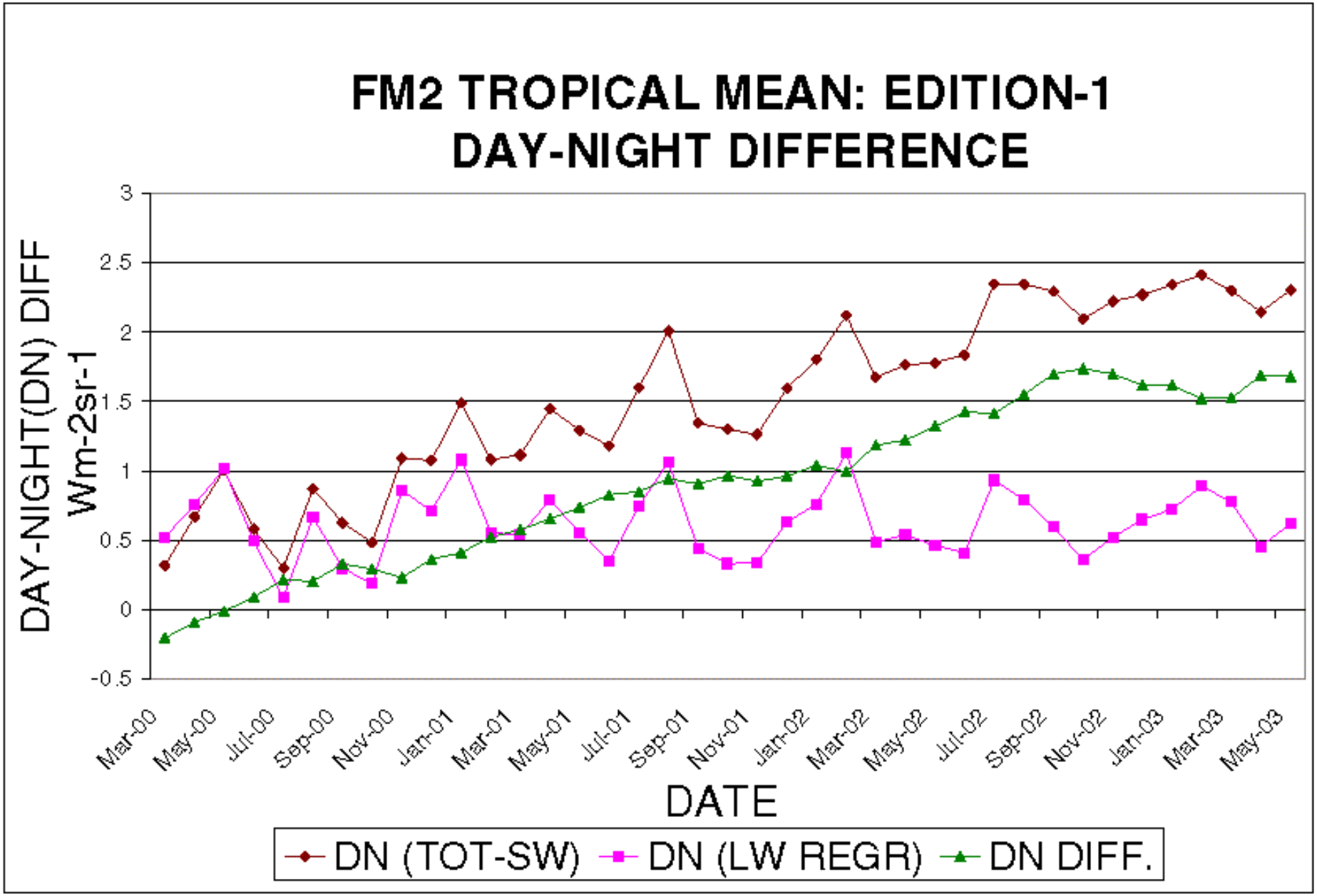

DAY NIGHT DIFFERENCE (DN) COMPARISON
Based on Longwave/ Window sensor
Based on Total & Shortwave Sensors
CERES Edition2 Data
DAY NIGHT DIFFERENCE (DN), Wm-2sr-1
2.5
2
1.5
1
0.5
0
-0.5
ERBS
CERES TRMM
CERES-TERRA FM1
CERES-TERRA FM2
CERES-AQUA FM3
CERES-AQUA FM4
DATE
3/85 2/90
1/98 8/98
3/00 12/03
3/00 12/03
6/02 2/04
6/02 2/04

DIFFERENCE IN TM DN VALUE

- DIFFERENCE BETWEEN THE TWO DN VALUES WILL TEST THE CONSISTENCY BETWEEN THE THREE SENSORS.

- TIME HISTORY OF THIS DIFFERENCE WILL SHOW ANY DRIFT THAT MAY OCCUR BETWEEN THE SENSORS.


TM VALUES: CERES FM2 INSTRUMENT
Edition1 Data Product
93
92
91
90
89
88
87
86
85
Mar-00
Jul-00
Nov-00
Mar-01
Jul-01
Nov-01
Mar-02
Jul-02
Nov-02
Mar-03
Jul-03
Nov-03
Mar-04
TMDAY (TOT-SW)
TMDAY (WINDOW)
TMNIGHT (TOTAL)
TMNIGHT (WINDOW)



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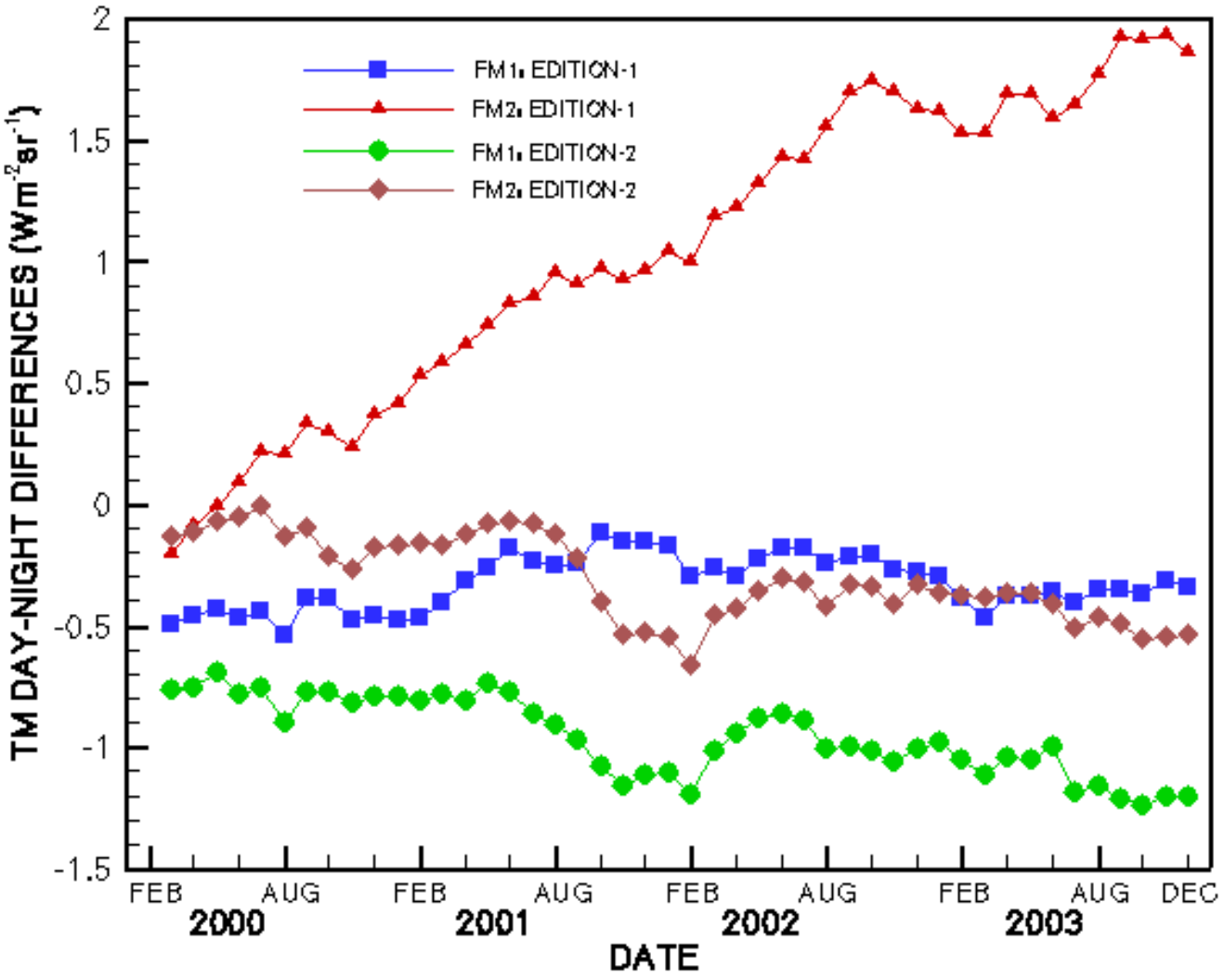
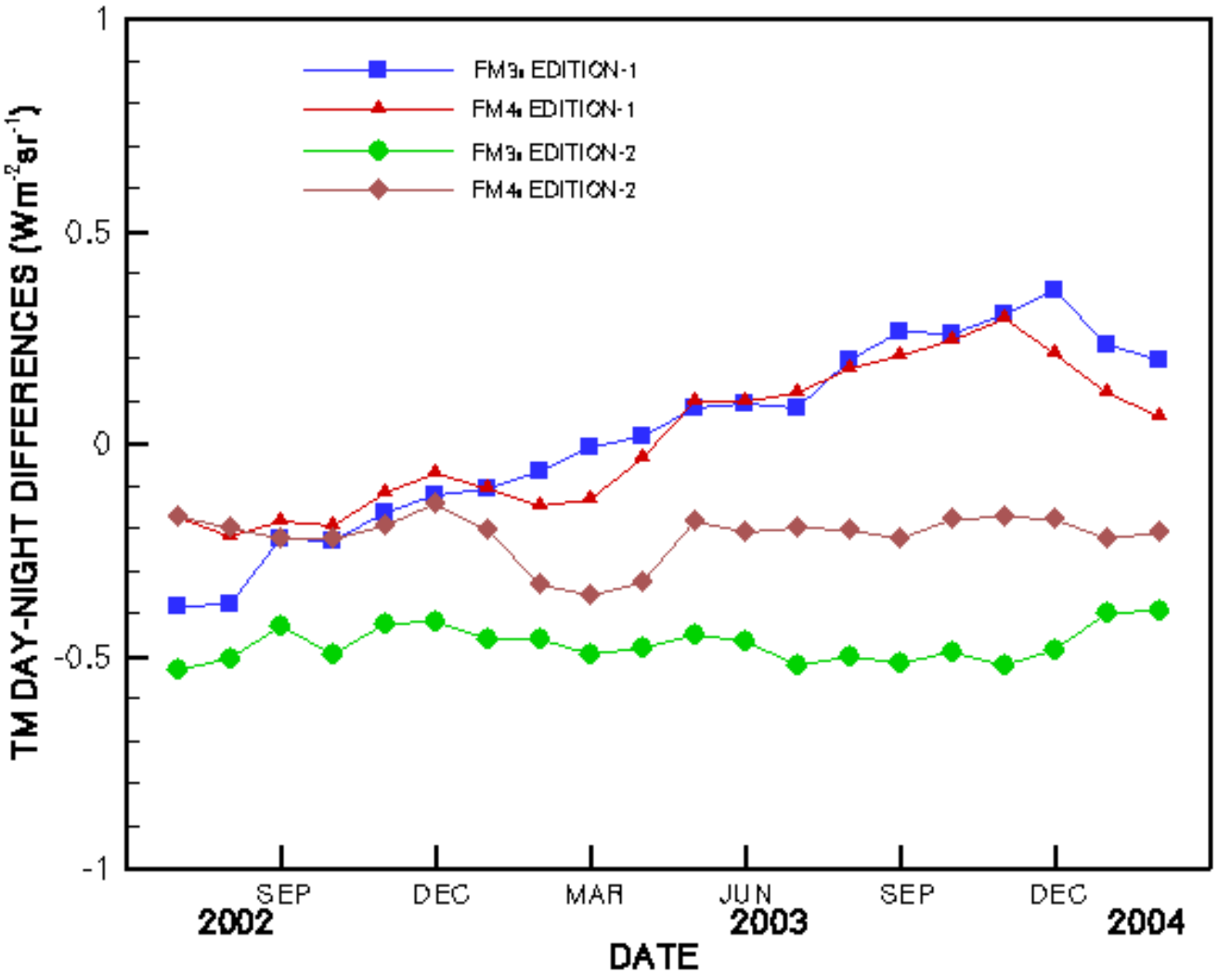
DIFFERENCE IN DN VALUE FOR TERRA INSTRUMENTS



DIFFERENCE IN DN VALUE FOR AQUA INSTRUMENTS



DIFFERENCE IN TM DN VALUE

- THE DN DIFFERENCE RESULTS FOR ALL CERES INSTRUMENTS HAVE SHOWN A RISE WITH THE EDITION-1 DATA.

- THE SHORTWAVE PORTION OF THE TOTAL SENSOR IS CORRECTED TO ACCOUNT FOR THE DRIFT.

CONCLUSION

- **TROPICAL MEAN (TM) IS A POWERFUL TOOL FOR INTERCOMPARISON BETWEEN CERES SENSORS.**
- **THE AVERAGE NIGHT TIME TM FOR CERES INSTRUMENTS ON TERRA AND AQUA SPACECRAFT IS 88.1 +/-0.3 $Wm^{-2}sr^{-1}$. CERES INSTRUMENTS ARE SHOWING A HIGHER TM VALUE THAN THE ERBS BASELINE VALUE OF 87.13 $Wm^{-2}sr^{-1}$.**

CONCLUSION

- TM ANALYSIS ALONG WITH OTHER VALIDATION STUDIES HAVE INDICATED A RISE IN THE DAYTIME MEASUREMENT OF TOTAL SENSOR ON ALL CERES INSTRUMENTS. CORRECTIONS ARE DONE ON EDITION-2 DATA.
- EDITION1 VS. EDITION2 (EDITION3)